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SOURCE OF FOOD ITEMS IN AN ABORIGINAL MIDDEN AT LITTLE DIP, NEAR ROBE, SOUTHEASTERN SOUTH AUSTRALIA: IMPLICATIONS FOR COASTAL GEOMORPHIC CHANGE

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Summary

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At Nora Creina Bay, in southeastern South Australia, fossil shell of the intertidal mollusc *Katelysia scalarina* from outcropping sediment yielded a radiocarbon age of 5600±140 y cal BP. The presence of intertidal sandflat sediments of this age, preserved in an open ocean coastal setting, implies that the western, mostly eroded side of Robe Range once sheltered quiet water embayments with intertidal sandflats. Radiocarbon ages for fossil molluscs from marine sediments landwards of Robe Range reveal that autochthonous deposition took place within an extensive Holocene coastal back-barrier lagoon environment from approximately 5500-4000 y BP. It was originally proposed that the shells of *Katelysia* cockles, gathered by Aboriginal people and now preserved within the archaeostratigraphic Early Horizon midden at Little Dip, had originated in this back-barrier lagoon. As the *Katelysia* sp. shell from the Early Horizon midden is more than 3000 y older than *Katelysia* spp. from the nearby autochthonous lagoonal sediments (e.g. at Fresh Dip Lake), it now seems that the cockles were harvested from intertidal sandflat environments on the seaward side of Little Dip, probably before marine incursion into the low lying land behind Robe Range. These sandflats were ephemeral features, eroded as the protective outer margin of Robe Range was also reduced by the erosive force of the Southern Ocean to a linear array of small islands and sea stacks that characterise the present coastline.

Key Words: South Australia, coastal, Holocene, Pleistocene, Aboriginal midden, mollusc, foraminifera, radiocarbon, amino acid racemisation.

Introduction

Coastal Aboriginal middens in the vicinity of Robe, southeastern South Australia, typically contain shell remains of marine molluscs and, in many instances, fragments of flint. The materials of the older Early Horizon sites (nomenclature of Luebbers 1978[‡]) lie on the exposed surface of Robe Range within terra rossa soils. Robe Range is a composite coastal barrier, comprising carbonate-quartz dune sands, which formed during the interstadial highstand sea level of oxygen isotope substage 5c (Schwebel 1983; Huntley *et al.* 1993; Belperio *et al.* 1996). Typically the shell remains of the Early Horizon middens are dominated by species of *Katelysia* Romer, an intertidal sandflat cockle commonly found today living in protected coastal settings (Ludbrook 1984); flint fragments are not commonly present. The younger and more numerous Late Horizon middens of Robe Range consist of thin beds of shell remains and flint fragments within the modern, unconsolidated dune sands that are related to the most recent postglacial marine transgression. The shells of these deposits, which are most frequently observed as lag deposits on deflation surfaces, are mostly of *Turbo (Subninella) undulatus* Solander, a large gastropod which is currently living along the modern rocky shoreface. Early Horizon middens record an episode of Aboriginal occupation of coastal Robe Range that approximates in time to the culmination of the postglacial marine transgression in the early Holocene, while the Late Horizon sites reflect more recent occupation (Luebbers 1978[‡]; Cann *et al.* 1991).

At coastal Little Dip, southeast of Robe, *Turbo* shells and flint fragments, together with finely disseminated charcoal, occur within unconsolidated dune sands and as a lag deposit across a modern deflation surface. Shell from this deposit yielded a marine reservoir corrected radiocarbon age, calibrated to sidereal years, of 470±160 y cal BP (Table 1), an age corroborated by amino acid racemisation (AAR) analysis (Cann *et al.* 1991). The dune sands and their contained archaeological remains immediately overlie scattered concen-

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TABLE 1. *Radiocarbon dates on Holocene molluscs and charcoal from Little Dip and environs near Robe, South Australia.*

Sample locality	Dated material	Laboratory code	$\delta^{13}C$ (‰)	Conventional ^{14}C age y BP	Calibrated and marine reservoir corrected ^{14}C age y cal BP
Fresh Dip Lake	*Katelysia scalarina* and *K. rhytiphora*	SUA-3028	1.0±1.0	3760±70	3680±200
Nora Creina embayment	*K. scalarina*	SUA-3029	1.0±1.0	5250±60	5600±130
Nora Creina Late Horizon midden	*Turbo* sp.	Beta-104522	1.6±0.1	1170±60	740±130
Little Dip Late Horizon midden	*Turbo* sp.	ANU-7417	0.0±2.0	840±80	470±160
Little Dip Early Horizon midden	*Katelysia* sp.	SUA-2613	1.0±1.0	7480±70	7900±160
Little Dip Early Horizon midden	charcoal	ANU-7418	-24.0±2.0	8270±80	9210±230

trations of *Katelysia* shells and charcoal which are embedded within a terra rossa soil on the otherwise calcreted and karstified sediments (oxygen isotope substage 5c) of Robe Range. Radiocarbon ages of 9210±230 y cal BP (ANU-7448) for charcoal and 7900±160 y cal BP (SUA-2613) for shell confirm an early Holocene age for the materials from the lower deposit (Table 1). These results are supported by previously published (AAR) analyses of *Katelysia* shell (Cann *et al.* 1991). Both deposits are the result of human activity, and their general setting and exposed materials were proposed as an archaeostratigraphic type locality and type sections for the time-cultural Early and Late Horizons of Aboriginal occupation in southeastern South Australia (Cann *et al.* 1991, 1998).

Cann *et al.* (1991) speculated about the origin of the *Katelysia* shells as a food source in the Early Horizon midden at Little Dip. These authors noted that, although the midden is situated in close proximity to the shore, there are currently no coastal intertidal sandflat environments which could have supported this edible cockle. However, they also observed that *Katelysia* spp. are abundant in both autochthonous and allochthonous bioclastic sediments, up to several m thick, exposed in excavations and lake beds within the low lying area immediately inland (northeast) of Robe Range. These Holocene shell beds were deposited in a coastal back-barrier lagoon which supported thriving populations of *Katelysia* and other molluscs. Cann *et al.* (1991) therefore concluded that this lagoon represented the most likely source of the cockles once gathered as food by the Aboriginal people who had lived on Robe Range about 8000 years ago. This paper re-evaluates the provenance of these midden materials in the light of additional field observations and radiocarbon ages.

Observations and Methods

Field observations

Nora Creina is the name given to a coastal area about 7 km southeast of Little Dip and adjacent to Nora Creina and Stinky Bays (Fig. 1). There are three major geomorphic elements present in this area. The oldest of these is Robe Range, comprising the mostly consolidated aeolian calcarenite that is associated with the interstadial highstand of sea level, oxygen isotope substage 5c, c. 105 000 y BP (Huntley *et al.* 1993). Since the culmination of the post glacial marine transgression and stabilisation of present sea level, this complex of former coastal dunes has undergone extensive erosion by the Southern Ocean and is now represented by numerous remnant small islands and offshore sea stacks. Many of these exhibit sections of aeolian cross beds and other dune forms (Fig. 2) and their upper surfaces are calcreted, karstified and support terra rossa soils. Numerous rhizomorphs attest to the role of former vegetation as an agent in carbonate diagenesis (Fig. 3).

The modern beach at Nora Creina, which is broad and exclusively sandy, is the second geomorphic element. The sand is carbonate-quartz in composition and derived, at least in part, from the erosional reworking of the older aeolianite of Robe Range. Some of the Robe Range sea stacks appear to have been instrumental in providing anchor points for beach construction, as regional uplift of c. 70 mm per thousand years (Belperio & Cann 1990; Belperio *et al.* 1996) promoted beach progradation. The beach

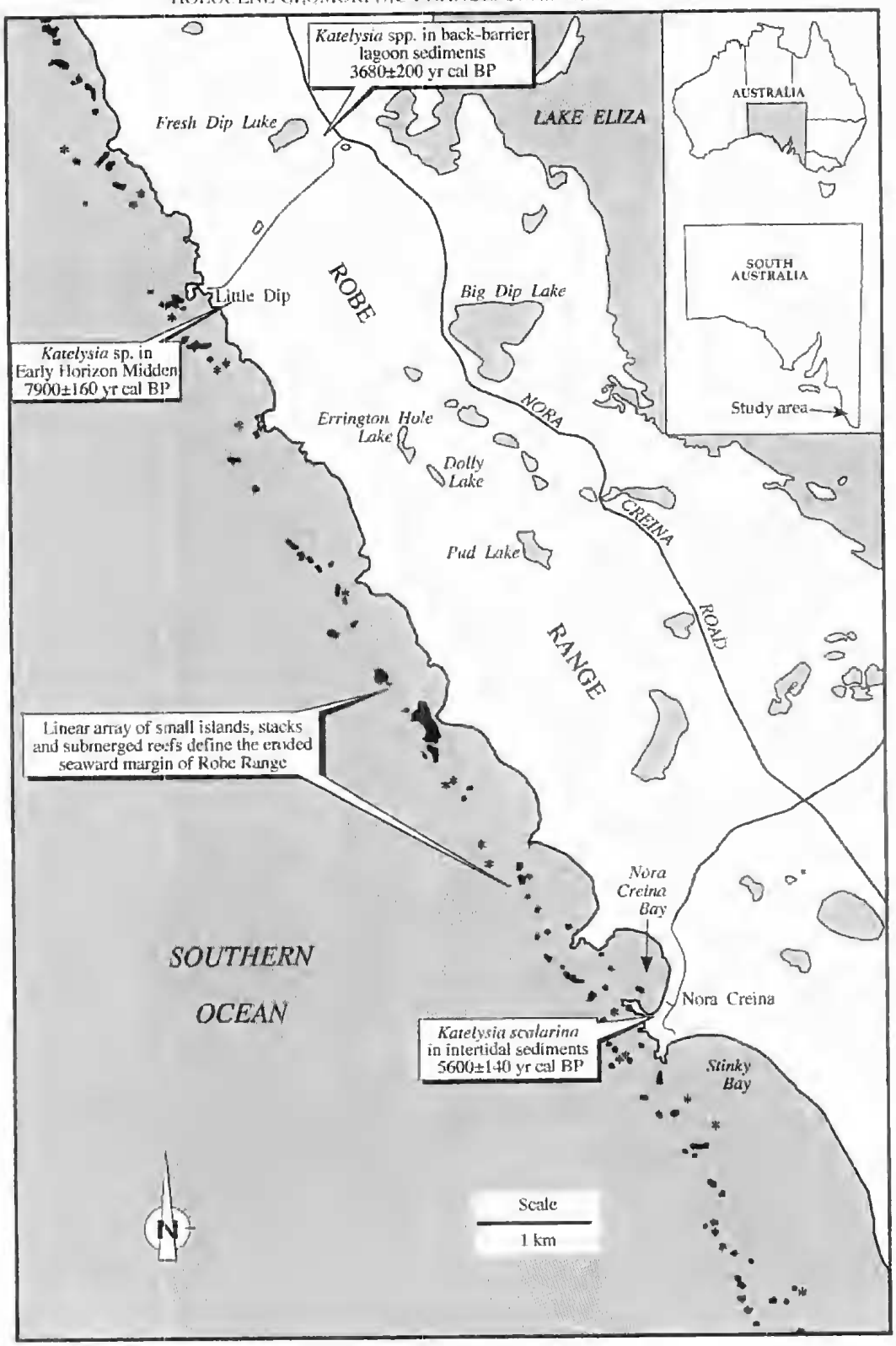

Fig. 1. Map of the study area showing the location of places mentioned in the text and some radiocarbon ages.

face of Nora Creina Bay rests between headlands of the older aeolianite (Fig. 2); similar aeolianites outcrop along the Stinky Bay beach (Fig. 3).

The beaches at Nora Creina and Stinky Bays are backed by a system of modern coastal dunes which comprise the third geomorphic element. The dune sands are similar in composition to, and presumably (at least originally) in dynamic equilibrium with, those of the beach. Sections through some of these dunes have exposed typical materials of the Late Horizon middens, namely shells of *Turbo* sp. and fragments of flint.

At the southeastern extremity of Nora Creina Bay, the modern high-tide beach sands abut a low wave cut exposure of poorly to moderately well-cemented sediments, about 1 m in height, and extending

Fig. 2. The rocky outcrop of Robe Range aeolian calcarenite, of age oxygen isotope substage 5c, which forms the southern headland of Nora Creina Bay. The dip slope towards the beach defines the lee side of the dune form. Motor vehicle on beach at right indicates scale.

Fig. 3. Exposed section through a stranded aeolianite sea stack at the back of the beach face of Stinky Bay. This exposure reveals two sets of aeolian cross beds which are variably lithified, numerous rhizomorphs (right), a calcreted upper surface and a small solution hole (upper right). Holocene dune sand overlies the aeolianite and a garden spade for scale stands in modern beach sand.

several m back from the headland. The base of the exposure is not defined. The lowermost lithology is a breccia of calcarenite clasts, which are, at least superficially, similar in texture and composition to the locally outcropping aeolianite of the Robe Range. The angular to subrounded fragments range in size upwards to the dimensions of cobbles and are embedded in a matrix of sand of the same composition (Figs 4, 5). The texture and composition of this sediment is consistent with having been derived from the substage 5e aeolian calcarenite and deposited as storm wave beach debris.

The overlying bed, 10-25 cm thick, is sediment of quite different character, consisting of well preserved mollusc shells in a carbonate-quartz sandy matrix (Figs 4, 5). The northern part of the exposure is poorly consolidated and reveals in section both articulated and disarticulated bivalve shells in a grey, carbonate-quartz, slightly muddy sand. The unpaired shells are oriented both convex up and down with several having an imbricated fabric (Fig. 6). The southern part of the outcrop reveals the fossil shells in both vertical and horizontal exposures within essentially clean, slightly better cemented, carbonate-quartz sand (Fig. 7). Bivalves include species of *Anapella* Dall, *Brachiodontes* Swainson, *Macoma* Linnaeus and *Katelysia*, and among the gastropods *Batillaria (Batillariella) estuarina* (Tate) is most common. From this sediment a specimen of *Katelysia scalarina* (Lamarck) was taken for radiocarbon dating and bulk sediment was also taken for foraminiferal analysis. The palaeoenvironment

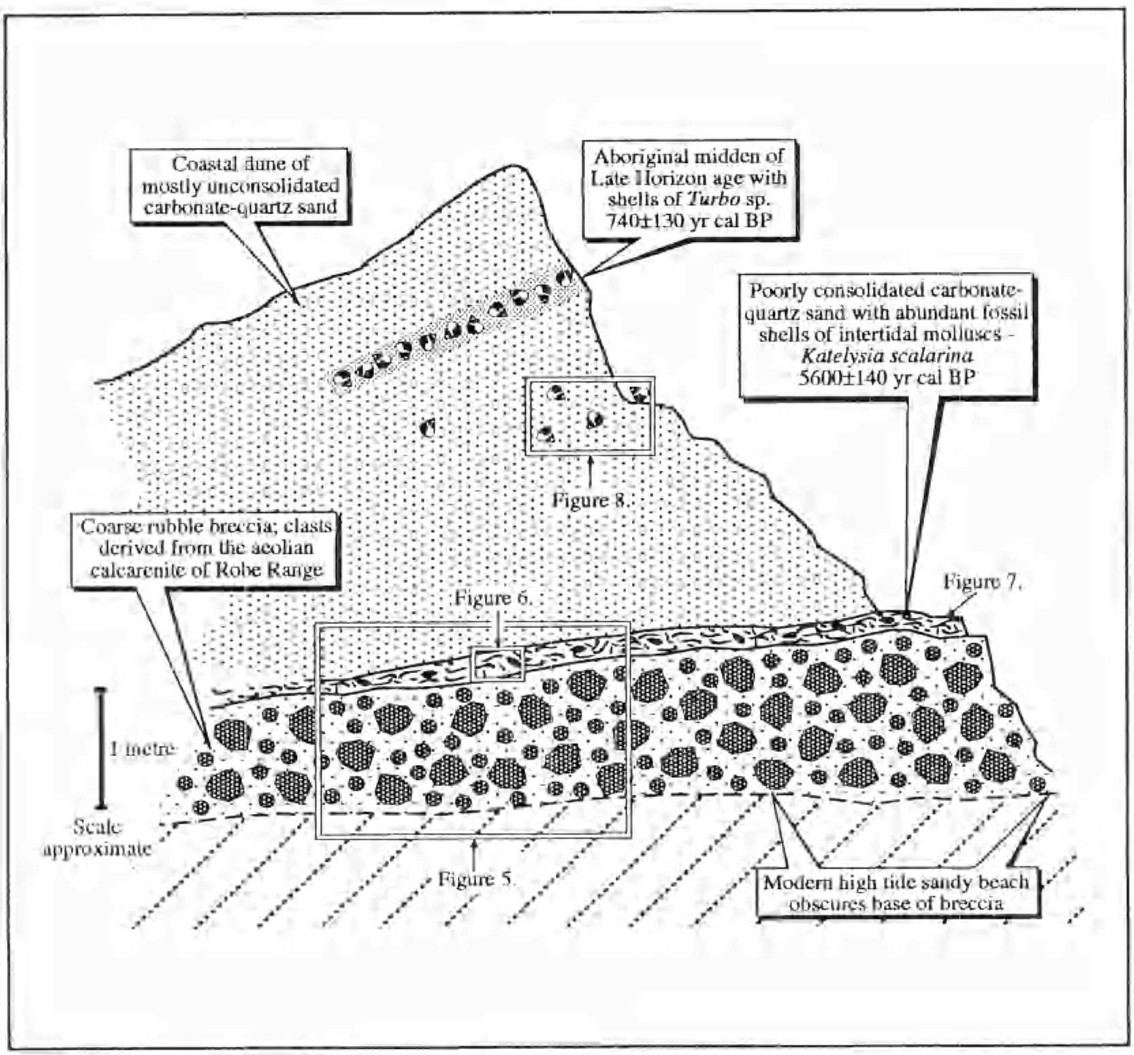

Fig. 4. Diagrammatic section of the exposure at the southern end of the beach at Nora Creina Bay. Also shown are the locations of features mentioned in the text and included as additional Figs 6-8.

that is signified by these fossil molluscs was at least closely similar to a modern intertidal sandflat and it is significant that such an environment once prevailed in a coastal setting which faced the Southern Ocean.

The shelly sandflat facies at Nora Creina Bay occurs up to 1 m above the modern high-tide sandy beach, and approximately 1.5 m above present mean sea level. Emergence of the shell bed may be attributed to the regional tectonic uplift, 490 mm in 7 ka (Belperio & Cann 1990), with superimposed hydroisostatic adjustments. The degree of hydroisostatic deformation for this setting is likely to be similar to that registered elsewhere at sites close to the continental shelf edge in southern Australia, such as at Port Lincoln, which records about 500 mm of emergence since the culmination of the post glacial marine transgression (Belperio 1995).

Overlying these beds of the shelly sandflat facies is a dune, 5-6 m high, of vegetated, but otherwise essentially unconsolidated carbonate-quartz sand. Included within the dune is an horizon of numerous

Fig. 5. Basal rubble breccia bed with cobble size clasts of reworked aeolian calcarenite, believed to represent storm wave beach debris. A sandy bed with preserved mollusc shells overlies the breccia. Geological hammer for scale.

Fig. 6. Detail of fossil mollusc shells, which are here mostly disarticulated, convex upwards and partly imbricated, signifying some degree of transportation. The pen indicates scale.

large shells of *Turbo* sp., together with an associated lag of shells on an erosion surface, which is here interpreted as a Late Horizon Aboriginal midden (Figs 4, 8). A specimen of shell was taken from this deposit for radiocarbon dating.

Radiocarbon dating

Radiocarbon dating of the fossil molluscs, involving liquid scintillation counting of residual radiocarbon, followed the conventional methods as documented by Gupta & Polach (1985). As pretreatment, before sample preparation, the fossil shells were rigorously etched in c. 4 M hydrochloric acid. The conventional radiocarbon ages were calibrated to sidereal years using the program of Stuiver & Reimer (1993), which included a correction for the marine reservoir effect for southern Australian ocean surface waters (–450±35 y) (Gillespie & Polach 1979). With the exception of the *Turbo* sp. from Nora Creina (Beta-104522), all the radiocarbon ages were calculated using estimated δ13C values. Results are reported in Table 1.

Fig. 7. Exposed upper surface of the shell bed. The pen indicates scale.

Fig. 8. Shells of *Turbo* sp. as a lag deposit derived from a Late Horizon Aboriginal midden in the dune. The larger shells are about 10 cm in diameter.

Micropalaeontology

The sediment sample collected from the shell bed cropping out at Nora Creina Bay was soaked in tap water to facilitate disaggregation and wet sieved to remove sediment grains <0.125 mm. The retained material was air dried and sieved to obtain the grain size fraction 0.50-0.25 mm for microscopic examination. Grains from this fraction were randomly sprinkled on to a picking tray, and the observed tests of foraminifera were identified and removed to a standard microfossil slide. However, polished or abraded tests, or those of yellow-brown colouration and infilled with authigenic cement, were excluded as these were all presumed to be relict. More than 300 individuals were extracted and identified, and the numerical abundance of species was evaluated as an indication of the palaeoenvironment.

Results and Discussion

Radiocarbon ages

The radiocarbon age determined for shell of *Katelysia scalarina* at Nora Creina Bay, calibrated to sidereal years, is 5600±140 y cal BP and that for *Turbo* sp. in the overlying dune sand is 740±130 y cal BP (Table 1). Cann *et al.* (1998) reported radiocarbon ages which indicate that the postglacial marine transgression into the coastal lagoon behind Robe Range was initiated c. 7500 y BP. Otherwise, fossil shells collected from autochthonous deposits of oysters and cockles within this lagoon consistently yielded dates around 5500-4000 y BP and shells from coquinoid deposits were as young as c. 2000 y BP. Thus the age for the shelly sediments at Nora Creina is consistent with sedimentation within the earlier part of the postglacial marine transgression and points to the formerly more extensive intertidal shelly sandflat environment on the seaward side of Robe Range.

Foraminifera

Microscopic examination of the sediment grain size fraction 0.50-0.25 mm, from the shelly sediment at Nora Creina Bay, revealed that three groups of foraminifera constitute almost three quarters of the assemblage. *Triloculina inflata* d'Orbigny + *T. oblonga* (Montagu) 16%, *Discorbis dimidiatus* (Parker & Jones) 30% and *Elphidium crispum* (Linne) 26%. Lesser species, each making up 3-5%, were *Nubecularia lucifuga* Defrance, *Spiroloculina antillarum* d'Orbigny, *Quinqueloculina subpolygona* Parr and *Triloculina trivarinata* (d'Orbigny). Such a distribution of species is consistent with a sand flat environment, as inferred from the molluscs. Species such as *Rosalina australis* (Parr), *Cibicides* sp. de Montfort and *Planulinoides biconcavus* (Jones & Parker), that might otherwise have signified more pronounced influence of the open ocean, are each represented by only a single specimen.

Coastal sandflats

During the early to mid Holocene, c. 5600 years ago, in the Nora Creina Bay area, the coastal marine setting hosted populations of marine molluscs and foraminifera which together imply the existence of an intertidal sandflat environment. It appears that, at the culmination of the postglacial marine transgression, such environments were initially created in sheltered areas, such as eroded embayments, and were adjacent to clusters of sea stacks and small islands (erosional remnants of the Late Pleistocene component of Robe Range). The aeolian calcarenites which comprise Robe Range are variably lithified and the fragmented nature of the present landscape attests to extensive erosion of the less consolidated sediments by the forces of the Southern Ocean. The eroded remnants of Robe Range can be traced for up to 1 km offshore and their presence implies an average rate of coastal recession of 143 mm y^{-1} since the culmination of the postglacial marine transgression some 7000 years ago. This local rate of cliff retreat is up to three times greater than that reported by Twidale (1997) for various sites on Eyre Peninsula. The large quantities of relict carbonate bioclasts, that impart the distinctive yellow-brown colour to the sands of the present day beach and the Holocene coastal dunes of the Robe Range complex, attest to the degree of erosion of the older aeolianite succession. With continued erosion of the protective stacks and islands at the seaward edge of Robe Range, the sandflats that had formerly hosted the intertidal fauna, as in the Nora Creina embayment, became exposed to unabated marine erosion. The sands were redistributed, partly as a transgressive blanket of parabolic dunes, constituting the most recent phase of construction of Robe Range and also partly along the coast to be deposited in the protected environments that were to become Guichen and Rivoli Bays. These latter sediments are now represented as a series of relict foredunes (Sprigg 1952; Cann *et al.* 1991, 1998).

Katelysia shells in the Early Horizon midden at Little Dip

Cann *et al.* (1991) originally proposed that the shells of *Katelysia* cockles, gathered as a food source by Aboriginal people, and now preserved within the archaeostratigraphic Early Horizon midden at Little Dip, had originated in the Holocene back-barrier coastal lagoon behind Robe Range. Large populations of molluscs, especially *Katelysia* spp., became established within this lagoon and their shelly remains accumulated forming extensive bioclastic sediments. As the radiocarbon age from

Katelysia sp. shell in the Early Horizon midden is more than 3000 y older than the ages from *Katelysia* spp. in the nearby autochthonous back-barrier lagoon sediments, it now appears unlikely that the shells in the midden had their origin in the lagoonal waterway. The radiocarbon dated fossil *K. scalarina* from Nora Creina confirms that, in sheltered settings along the Holocene coast, hospitable environments prevailed for this mollusc. It would seem that, in the early Holocene, Aboriginal people harvested the cockles from intertidal sandflat environments on the seaward side of Little Dip. As may be inferred from the available radiocarbon data (Cann *et al.* 1998), this was probably several hundred years before the postglacial marine transgression flooded the low lying land behind Robe Range.

Conclusions

At the culmination of the postglacial marine transgression, the seaward side of Robe Range, near Nora Creina and Little Dip, provided sheltered back-barrier settings in which sands were deposited and intertidal molluscs, especially *Katelysia* spp., were able to thrive. Aboriginal people gathered these cockles as a food source, as evidenced by the abundant shell remains in the Early Horizon midden at Little Dip. The less consolidated parts of the beach/dune barrier succumbed to the erosive forces of the Southern Ocean, thus reducing this feature over time to the linear array of sea stacks and small islands that characterise the seaward edge of Robe Range today. The unprotected sandflats were thus exposed to the open ocean and their sediments were redistributed. Much sand was blown onshore as a blanket of transgressive coastal dunes. Sand was also transported along the coast and deposited in the sheltered areas that became Guichen and Rivoli Bays. Radiocarbon ages for the Early Horizon midden shells at Little Dip, and for the *Katelysia scalarina* from the sandflat facies at Nora Creina, constrain this environmental change to the time interval c. 8000-5600 y BP.

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References

Belperio, A. P. (1995) Quaternary pp. 219-280 *In* Drexel, J. F. & Preiss, W. V. (Eds) "The Geology of South Australia, Vol. 2, The Phanerozoic". *Bull. Geol. Surv. S. Aust.* **54**.

_____ & Cann, J. H. (1990) "Quaternary evolution of the Robe-Naracoorte coastal plain: an excursion guide" *S. Aust. Dept Mines and Energy Rept Book*, **90/27**.

_____, _____ & Murray-Wallace, C. V. (1996) "Quaternary coastal evolution, sea level change and neotectonics: the Coorong to Mount Gambier coastal plain, southeastern Australia. An excursion guide" IGCP Project 367. Mines and Energy, South Australia.

Cann, J. H., De Deckker, P. & Murray-Wallace, C. V. (1991) Coastal Aboriginal shell middens and their palaeoenvironmental significance, Robe Range, South Australia. *Trans. R. Soc. S. Aust.* **115**, 161-175.

_____, Murray-Wallace, C. V., Belperio, A. P. & Brenchley, A. J. (1999) Evolution of Holocene coastal environments near Robe, southeastern South Australia. *Quat. Int.* **56**, 81-98.

Gillespie, R. & Polach, H. A. (1979) The suitability of marine shells for radiocarbon dating of Australian prehistory pp. 404-421 *In* Berger, R. & Suess, H. (Eds) *Proc. 9th Int. Con. on Radiocarbon Dating* (University of California Press, Berkeley).

Gupta, S. K. & Polach, H. A. (1985) "Radiocarbon dating practices at ANU" (Radiocarbon Laboratory, Research School of Pacific Studies, Australian National University, Canberra).

Huntley, D. J., Hutton, J. T. & Prescott, J. R. (1993) The stranded beach-dune sequence of south-east South Australia: a test of thermoluminescence dating, 0-800 ka. *Quat. Sci. Rev.* **12**, 1-20.

Ludbrook, N. H. (1984) "Quaternary molluscs of South Australia" *S. Aust. Dept Mines and Energy Handbook* **9**.

Schwebel, D. A. (1983) Quaternary dune systems pp. 13-24 *In* Tyler, M. J., Twidale, C. R., Ling, J. K. & Holmes, J. W. (Eds) "Natural History of the South East" (Royal Society of South Australia, Adelaide).

Sprigg, R. C. (1952) The geology of the south east province of South Australia, with special reference to Quaternary coast-line migrations and modern beach developments. *Bull. Geol. Surv. S. Aust.* **29**.

Stuiver, M. & Reimer, P. J. (1993) Extended 14C data base and revised calib 3.0 14C age calibration program. *Radiocarbon* **35**, 215-230.

Twidale, C. R. (1997) Some recently developed landforms: climatic implications. *Geomorphology* **19**, 349-365.